ABUNDANCE AND DISTRIBUTION OF MOTHS OF THE FAMILIES SATURNIIDAE AND SPHINGIDAE IN SANJAY GANDHI NATIONAL PARK, MUMBAI[1]

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(*With five text-figures*)

Key words: Saturniidae, Sphingidae, Lepidoptera, abundance, distribution, Sanjay Gandhi National Park

In order to study the ecology of moths belonging to Families Saturniidae and Sphingidae, a three-year study was conducted in Sanjay Gandhi National Park, Borivali, Mumbai. During the study, two species of Saturnids and sixteen of Sphingids were recorded. Range extension for four species of Family Sphingidae was recorded. Abundance ratio of Sphingids and Saturnids was found to be 80:20. It was observed that the activity of moths begins in the early monsoon, reaches a peak in mid-monsoon, and is slowly reduced by the end of post-monsoon. The abundance of these moths was greatly dependent on the availability of the foodplants. During monsoon, all the foodplants were in full foliage; therefore the maximum abundance of all the species was recorded in this season.

Introduction

Species richness of moths in India is related to heavy rainfall, high floristic diversity, whereas arid and semi-arid regions with low floristic diversity have a smaller number of species. Hence, some of these moths can be termed as Indicator Species. Earlier studies on moths emphasized their taxonomy, and very little is known about their ecology, except for some pest species.

Sanjay Gandhi National Park (SGNP), the study area is among the very few national parks in India which are surrounded by a metropolis like Mumbai. It is constantly under heavy biotic pressure from humans. This national park forms part of the Western Ghats, a crucial area with rich biodiversity. Though most of the flora and fauna is well documented, very little is known about the insect fauna of the park area.

Family Saturniidae

The Saturniidae are known as Emperor Moths or Non-mulberry silkmoths (Arora and Gupta, 1979). The Atlas moth is the largest moth in the world, having a wingspan of 33 cm (Kehimkar, 1997). Others like Tussar, Muga and Eri moths are known for their silk producing capacity and are commercially exploited by the silk industry.

Nearly 40 species are found in India (Arora and Gupta, 1979), mostly confined to the moist forests and plains. The adults are brightly coloured with hyaline patches on their wings. The males are smaller than the females and have feathery antennae, while females have narrow antennae. The caterpillars are robust, distinctly segmented, often with sparse hairs and tubercles. The cocoons are large, of fine or coarse silk, either oval, attached to a twig by a silken peduncle, or elongated, woven loosely among the foliage.

Family Sphingidae

The Sphingidae are known as Hawk moths. They are known to travel long distances on migration; some have even been encountered at mid-sea by ships (Kehimkar, 1997).

According to Imms (1957) there are 1000 species existing throughout the world. Nearly 200 species are recorded from India (including Andamans), Myanmar and Sri Lanka, out of which 134 species are known to occur in the Eastern Himalaya alone (Beeson, 1941). The

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stout, cigar-shaped body and long, narrow forewings of the adults are distinctive. The very long proboscis makes hawk moths ideal pollinators for flowers with long tubular corolla (Barlow, 1982).

Study Area

The SGNP is situated in Greater Bombay and Thane districts, occupying 44.50 sq. km and 58.64 sq. km respectively. The total area of the park is approx. 103 sq. km. It is situated about 40 km to the north of Mumbai city and about 8 km from the Arabian Sea. It has four types of habitats ranging from mangroves to the evergreen forests of Western Ghats. Most of the trees are deciduous and at places evergreen. The forest has a diversity of flora ranging from the tallest trees to ground layer shrubs and herbs.

Apart from the SGNP area, the study was also carried out on the adjoining 1.5 sq. km land of the Bombay Natural History Society (BNHS) at Goregaon. The vegetation of the BNHS land is of southern moist-mixed deciduous type, and the topography is mainly hilly intersected with rocky streambeds. There are seasonal rainfed streams.

Materials and Methods

Weekly field visits were conducted from January 1994 to December 1997 in different parts of the study area. Besides observing the caterpillars in the wild, a few caterpillars of each species were reared in captivity.

The caterpillars were usually located on their foodplants. Half-eaten leaves or fully defoliated branches gave clues to their presence. In some species, caterpillars were found on the underside of the leaf, whereas some were seen resting alone on the defoliated branch. Newly hatched caterpillars were found on clusters of young leaves of the foodplant. Frass particles below the foodplant were also helpful in spotting caterpillars. The size of the frass particles was useful in estimating the approximate instar of the feeding caterpillar.

Eggs and caterpillars collected from wild were reared in the laboratory. The egg bearing leaf was kept fresh by removing all other leaves from the stem and then it was placed in a bottle with water. The narrow neck of the bottle was plugged with cotton. The stem was then covered by a plastic bag secured by a rubber band at the neck of the bottle.

Newly hatched caterpillars were transferred to fresh foodplants with tender leaves, placed in plastic containers having perforated lids. Tissue paper was placed at the bottom of the container to absorb moisture from frass collected in the jar. This kept the jar dry for longer periods, preventing fungal, bacterial and viral infections. Fresh leaves were given every morning and evening. Usually the container was cleaned every morning. However, when caterpillars were nearing final instar, they became voracious feeders and the containers had to be cleaned twice a day. In order to provide protection from ants, the containers were placed in a plate filled with water. While the foodplants were collected, a careful search was made to remove predators like spiders and ants, and the plants were stored in a refrigerator.

Detailed notes on the appearance of the caterpillar and measurements were taken of each instar. Behavioural aspects and effects of climatic factors were also studied and noted. As the caterpillar reached maturity, pupation sites were prepared for those pupating under the soil or amongst the leaf litter inside a big plastic jar. In case of doubt, both options were provided. A few twigs were placed in the jar for the emerging moth to climb up and dry its wings. To make a representative collection, adults of each species were killed in a killing jar using ethyl acetate.

To study the species' attraction to light and also to make a checklist of moths, light traps were set up in the study area. However, due to rainfall and unsuitable locations, these attempts

were not very successful. Based on the specimens collected and field observations, the abundance and distribution have been studied.

Results

A. Moth Activity

It was observed that moth activity was greater during the monsoon and post-monsoon period, when larval foodplants were available in abundance. With ample food resources, egg laying was at a peak. Abiotic factors such as rainfall, temperature and humidity played a vital role in influencing the distribution and abundance. Moth activity began by early monsoon season and reached a peak level in mid-monsoon season, slowly decreasing, by the end of post-monsoon period.

1. Rainfall: In Mumbai, normal precipitation reaches about 2600 mm p.a. as per data obtained from the Meteorological Department, Santacruz, Mumbai, (Table 1). The mean monthly rainfall for three years showed that maximum rainfall was received during July, while the monsoon begins from June and ends in October. A correlation was drawn between the rainfall and moth activity (Fig. 1). It showed that though the maximum rainfall (87 mm) was received in July, the moths were found to be active from April onwards. The moth activity progressively increases till August, and reached a peak, while the rainfall had reduced to 43 mm. From September onwards there was a gradual decrease in the moth activity till the coming April.

2. Temperature: It was observed that fluctuation in maximum temperature was nearly 4°C, whereas the fluctuation in minimum temperature was approximately 10°C, more than twice that of maximum temperature (Table 1). Rise in temperature was observed from March onwards till November except in August and September. The correlation between the moth activity and the temperature (Fig. 2) showed that fluctuation among maximum and minimum temperature was low during August and September, which leads to a peak level in moth activity.

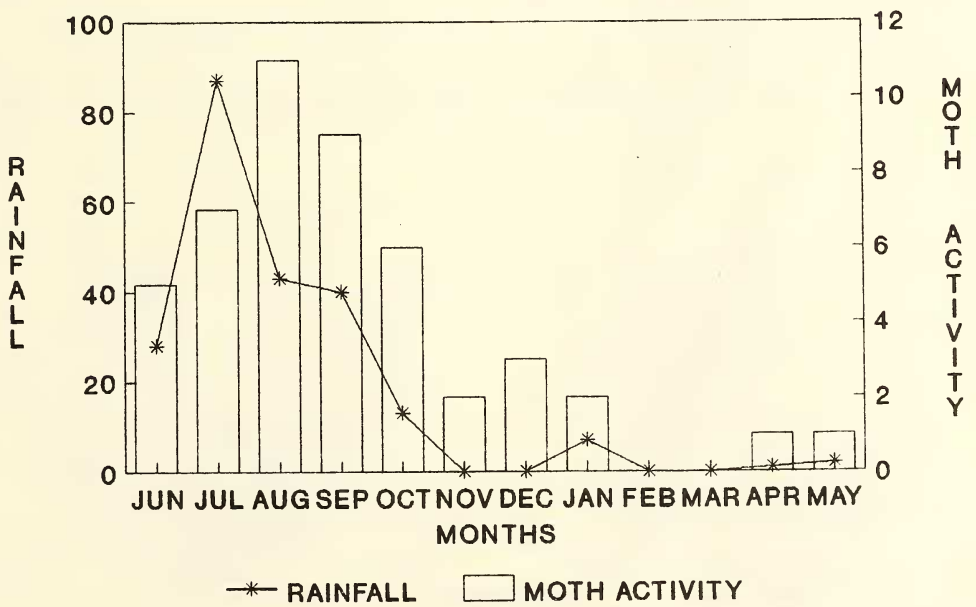

Fig. 1: Rainfall / activity of moths (1994-96)

TABLE 1
MEAN MONTHLY CLIMATIC FACTORS (1994-97)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	07	0	0	01	02	28	87	43	13	0	0	0
Temperature (°C)												
Max.	30	31	33	33	34	33	31	30	30	33	33	31
Min.	17	18	22	24	27		26	26	25	24	21	18
Humidity (%)												
Max.	86	88	86	88	83	89	95	92	92	90	85	88
Min.	26	25	32	38	54	68	75	72	66	39	28	27

3. Humidity: Being close to the Arabian Sea, the study area is always humid. The data on humidity (Table 1) showed that the maximum humidity was never less than 85% and the minimum humidity was always more than 25%. The rise in humidity was observed from June to October whereas the decline was from November to May. The effect of humidity on moth activity was analysed (Fig. 3). It showed that fluctuation between maximum and minimum humidity was low during July and August. Moths preferred high humidity levels for their activity.

Hence, it was concluded that for peak level in moth activity, the optimum requirements were rainfall 43 mm, humidity 92% and temperature 30 °C. These conditions were achieved in August. This relation has been drawn from Figs. 1, 2 & 3.

B. Abundance

Out of the 40 recorded species of Saturniidae and 181 species of Sphingidae in India, 2 Saturnids and 14 Sphingids were studied. The analysed data on moth species (Figs. 4 and 5)

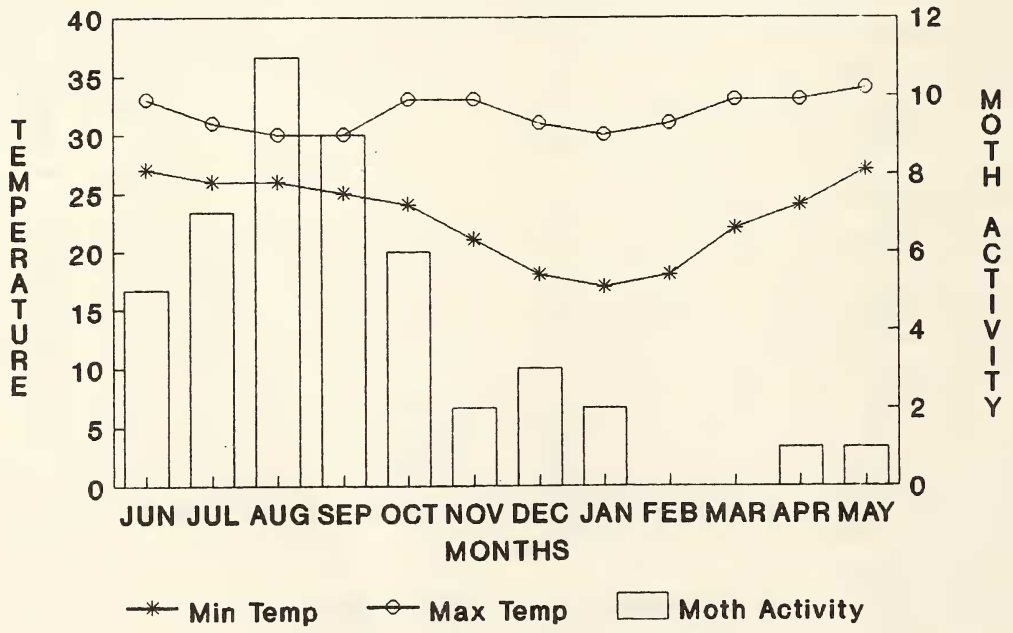

Fig. 2: Temperature / activity of moths (1994-96)

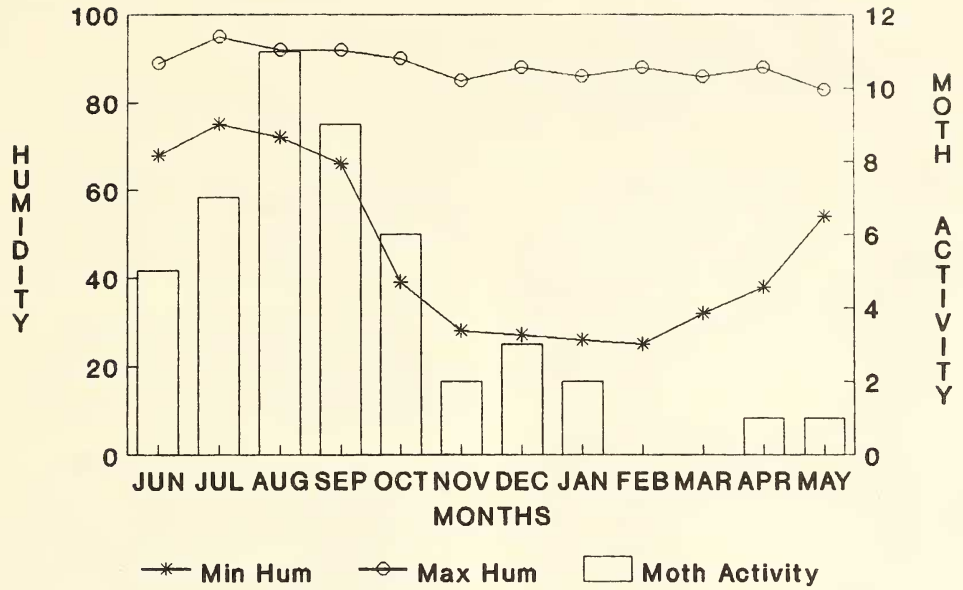

Fig. 3: Humidity / activity of moths (1994-96)

shows the abundance of individual species as well as the abundance component of each Family as percentage of the total number of species.

From Fig. 4, it was concluded that among the Saturnids, *Antheraea paphia* was more abundant than *Actias selene*. However among Sphingids, *Macroglossum gyrans* had the highest abundance. The next species among Sphingids was *Theretra lycetus*, which has the second highest abundance, but within restricted period. This was followed by *Nephele didyma, Marumba dyras* and *Cephanodes hylas*, and the remaining ten species (1 Saturnid, 9 Sphingids) form a minor share, hence they are categorized as 'Others' in Fig. 4.

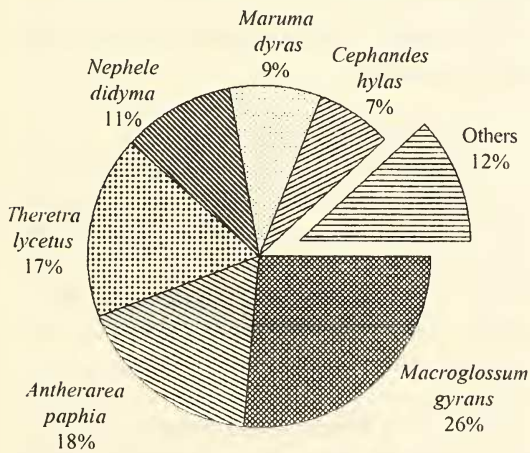

Fig. 4: Abundance of moths species-wise

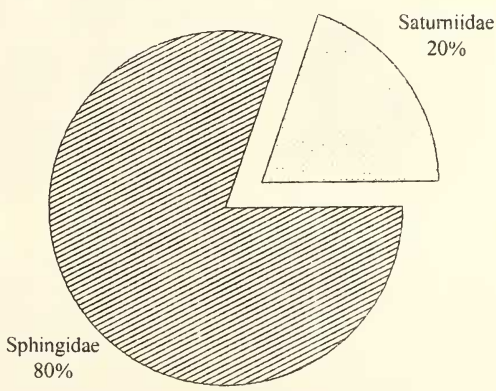

Fig. 5: Abundance of moths family-wise

TABLE 2
MONTHLY DISTRIBUTION OF MOTHS (1994-97)

Moth Species	No.of Moths	Months
Family Saturniidae		
1. *Actias selene*	02	Jul, Aug
2. *Antheraea paphia*	05	Jun, Jul, Aug, Sep, Oct
Family Sphingidae		
Subfamily Sphinginae		
1. *Acherontia lachesi*	02	Jul, Aug
2. *Acherontia styx*	01	Apr
3. *Clanis phalaris*	02	Jun, Jul
4. *Polyptychus dentatus*	02	Oct, Dec
5. *Marumba dyras*	03	Jul, Aug, Sep
Subfamily Macroglossinae		
11. *Cephanodes hylas*	04	Jun, Jul, Aug, Sep
12. *Nephele didyma*	07	Jun, Jul, Aug, Sep, Oct, Nov, Dec
13. *Gurelca hyas*	03	Jun, Aug, Oct
14. *Macroglossum gyrans*	20	Jan, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec
15. *Macroglossum belis*	05	Jan, Jun, Jul, Sep, Dec
16. *Theretra nessus*	01	Sep
17. *Theretra clotho*	03	Jul, Aug, Sep
18. *Theretra alecto*	01	Aug
19. *Theretra lycetus*	04	Jul, Aug, Sep, Oct
20. *Theretra oldenlandiae*	01	Jun
21. *Rhyncholaba acteus*	01	Sep

From Fig. 5, it was concluded that the abundance of Sphingids was much higher than that of Saturniidae, the abundance ratio being 80:20.

C. Range Distribution and Occurrence

The range distribution and occurrence period of moth species is mentioned below. The range distribution pertaining to the Indian subcontinent is as described by Hampson (1892-96), Beeson (1941), Arora and Gupta (1979) and Barlow (1982). The details of occurrence are as per the data collected and presented in Table 2.

a. Family Saturniidae

The Saturnids are widespread over the moist hill forest areas in India, often at low elevations, but they are typically subtropical and only occasionally are they plains species (Beeson, 1941). Out of the 40 recorded species from India, two species were recorded from the study area.

1. ***Actias selene*** (Hubner)

Distribution: The species is widely distributed throughout India, Nepal, Bhutan, Bangladesh, Myanmar, Sri Lanka. Occurrence period: July-August. Foodplant: *Lannea coromandelica*, a deciduous tree that bears new leaves in monsoon.

2. ***Antheraea paphia*** (Linnaeus)

Distribution: The species is restricted to moist hill forest areas and plains. Found throughout India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, Myanmar in suitable habitat. Occur-rence period: June-October. Foodplant: *Zizyphus mauritiana, Terminalia crenulata, T. bellerica, Anogeissus latifolia* and *Bridelia retusa*.

b. Family Sphingidae

The Sphingids are mostly confined to hilly areas and plains. Out of the 181 species recorded

for India, 16 were recorded from the study area.

Subfamily Sphinginae

1. ***Acherontia lachesis*** (Fabricus 1798)
Distribution: Throughout India, Sri Lanka. Occurrence period: July and August. Foodplant: *Ipomea carnea*, a perennial climber.

2. ***Acherontia styx*** (Butler 1876)
Distribution: Throughout India, Sri Lanka. Occurrence period: April. Foodplant: *Ipomea* sp.

3. ***Clanis phalaris*** (Hubner 1818)
Distribution: It is mainly found in eastern India, in Sikkim and extralimitally in Malaya. The present record from Mumbai is a range extension. Occurrence period: June and July. Foodplant: *Pueraria tuberosa,* a perennial climber.

4. ***Polyptychus dentatus*** (Cramer 1818)
Distribution: Old Bombay State, West Bengal, Eastern and Northwest Himalaya. Occurrence period: October and December. Foodplant: *Cordia dichotoma*, a deciduous tree.

5. ***Marumba dyras*** (Butler 1875)
Distribution: The known distribution range was Northwest and Eastern Himalaya, Assam, Karnataka, Andamans and Sri Lanka, and the present record is a westward range extension. Occurrence period: July- September. Foodplant: *Bombax ceiba, Firmania colorata, Helicteres isora* and *Grewia tiliaefolia.*

Subfamily Macroglossinae

1. ***Cephanodes hylas*** (Linnaeus 1771)
Distribution: Throughout Indian subcontinent. Occurrence period: June to September. Foodplant: *Mitragyna parvifolia, Hymenodictyon orixense, Haldina cordifolia, Gardenia lucida, G. grandiflora* and *Pavetta indica.*

2. ***Nephele didyma*** (Fabricius 1775)
Distribution: Throughout India, Sri Lanka. Occurrence period: June to December. Foodplant: *Carrisa carandas*, an evergreen shrub.

3. ***Gurelca hyas*** (Walker 1856)
Distribution: This record is a range extension and a new record for Mumbai. The known habitat range was Sikkim and Bangladesh. Occurrence period: June to August. Foodplant: *Morinda tinctoria* var *tomentosa*, an evergreen tree.

4. ***Macroglossum gyrans*** (Walker 1856)
Distribution: Throughout India, Sri Lanka. Occurrence period: June to September. Foodplant: *Morinda tinctoria* var *tomentosa*, an evergreen tree.

5. ***Macroglossum belis*** (Cramer)
Distribution: Throughout India, Sri Lanka, China. Occurrence period: January, June, September, and December. Foodplant: *Morinda tinctoria* var *tomentosa*, an evergreen tree.

6. ***Theretra nessus*** (Drury 1773)
Distribution: Throughout India, Sri Lanka, Myanmar. Occurrence period: September. Foodplant: *Dioscorea sp.*

7. ***Theretra clotho*** (Drury 1773)
Distribution: Throughout India (including Andamans), Sri Lanka, Myanmar. Occurrence period: June to September. Foodplant: *Ampelocissus latifolia*, a seasonal monsoon climber.

8. ***Theretra alecto*** (Linnaeus 1758)
Distribution: Throughout India, Sri Lanka, China. Occurrence period: August. Foodplant: *Ampelocissus latifolia*, a seasonal monsoon climber.

9. ***Theretra lycetus*** (Cramer 1775)
Distribution: This record is a range

extension for Mumbai; the earlier records were from Mussoorie, Sikkim, Sri Lanka. Occurrence period: July to October. Foodplant: *Leea asiatica* and *L.macrophylla*, a seasonal monsoon herb.

10. ***Theretra oldenlandiae*** (Fabricius 1775)

Distribution: India. Occurrence period: June. Foodplant: *Ampelocissus latifolia*, a seasonal monsoon climber.

11. ***Rhyncholaba acteus*** (Cramer 1779)

Distribution: India. Occurrence period: September. Foodplant: *Amorphophallus commutatus, Leea asiatica*, seasonal monsoon herbs.

Discussion

Environmental factors such as rainfall, temperature and humidity are important as they influence the distribution and abundance of insects and their food plants under study (William, 1987). The study showed that two families of moths have considerable ecological variations. The moths of family Sphingidae are eight times as abundant as the family Saturniidae. This coincides with the overall pattern recorded in India, Saturniidae as such comprises of fewer species i.e. 40 and Sphingidae has nearly 181 species. It was also observed that while the distribution range and occurrence of the two families vary, there is some overlapping of distribution range. Saturnids are mostly confined to moist hill forests, whereas Sphingids occur in forests as well as in plains. This being a subtropical group, it is distributed widely in diverse habitats. It was found that four species of Sphingidae had range extension for the study areas, as the earlier known range for *Clanis phalaris, Marumba dyras, Gurelca hyas* and *Theretra lycetus* was only northeast India.

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